GENERAL NOTES.

The *Astronomical Journal*, No. 551, contains an article by PAUL S. YENDELL, on "The Light Variations of 320 *U Cephei*." The variability of this star, of the *Algol* type, was announced by CERASKI in 1880, and as there were but five stars of this interesting class of variables known at that time, the announcement attracted considerable attention.

Mr. YENDELL has collected all the observations of this star, —over three thousand altogether,—and has made a very careful discussion of them to determine the form of the light-curve. The magnitudes of the comparison-stars were determined photometrically by Dr. MÜLLER, of Potsdam; and CHANDLER'S elements, which were found to represent the observations very closely, were used in the discussion. As an indication of the care with which the investigation has been made and of the refinement obtained in variable-star observations, it might be noted that it was necessary to discuss separately the observations made in the spring and those made in the autumn. A small but appreciable difference is found in the resulting curves, the difference being, in all probability, a subjective rather than a real one, caused by the different relative positions of variable and comparison-stars in east and west hour-angles. It is to be regretted that no photometric observations of this star have been made, because with a properly arranged photometer this subjective effect can be entirely eliminated. It is to be regretted, also, that Mr. YENDELL has not published graphical representations of the curves derived. These help the reader immensely in properly grasping the results of the investigation. Regret number three may be in order at this point. YENDELL'S results have been obtained from discussion of the observations of eight persons,—BAXENDELL, senior and junior, CHANDLER, KNOTT, PLASSMANN, SCHWAB, SPERRA, and YENDELL. Only one of the series of observations made by these persons, KNOTT'S, and a part of PLASSMANN'S, have been published. All of the other observations, fully two thirds of the whole, were transmitted to Mr. YENDELL in manuscript. And so it is, if any one wishes to make an exhaustive study of the light-variations of any variable, it is necessary to send letters all over the world and ask variable-star observers to transmit their

observations. This they are usually very glad to do, but it is easily seen that it would be much better for both observer and computer if the variable-star observations could be published. It is respectfully suggested that this might be an appropriate matter for the trustees of the Carnegie Institution to take under consideration. S. D. T.

The *Astronomical Journal,* No. 553, contains the results of some important investigations by Dr. CHANDLER, being a revision of the elements of his third catalogue of variable stars, published in 1896. All observations *published* since that time have been used in determining the revised elements. An important feature of the tabulation published is contained in the last three columns, which give the number of maxima and the number of minimi that have been used in deriving the revised elements, together with the limiting dates between which the observations were made. The observer can see at a glance which stars are in most need of observation. S. D. T.

The Memoirs of the British Astronomical Association, Volume XI, Part IV, contain the fifth report of the section for the observation of variable stars. The observations were made by about twenty members of the Association, under the direction of Col. E. E. MARWICK, and the present report covers the work done in the three years 1900-1902. The instruments used vary in size from one to twelve inches, the larger instruments being reflectors. The programme included the observation of four variables of the *Algol* type, nine short-period, twenty-five long-period, and eight irregular ones, and a total of 7,450 observations were made. These observations have all been reduced, and the resulting light-curves graphically represented in the memoir, a feature to be highly commended. S. D. T.

In *Monthly Notices of the Royal Astronomical Society,* Volume LXIII, No. 9, there is an important article by Professor WADSWORTH, Director of the Allegheny Observatory, on "The Construction of Telescopes Whose Relative or Absolute Focal Length Shall Be Invariable at All Temperatures." Two chief factors are to be reckoned with in this investigation, —the change in the focal length of the lens combination, and

the change in the length of the telescope tube, and, for practical purposes, the problem will be solved if these two parts of the telescope be constructed of such materials that the change in the one is just compensated by the change in the other. There are three variables at the disposal of the investigator, the density of the crown glass, the density of the flint glass, and the material of the telescope tube. Professor WADSWORTH's attention was first called to this subject by the peculiar behavior of the new steel-tube meridian-circle of the Naval Observatory. While using this new instrument Professor UPDEGRAFF found an unmistakable change in its apparent focal length with changes of temperature; and it now appears that the amount of the change agrees very closely with that deduced by Professor WADSWORTH from the theoretical considerations. It appears, from the investigation, that for the lenses usually used for meridian-circles a brass tube gives almost perfect compensation, but a steel tube does not. It is possible, however, to so vary the glass of the lenses that compensation may be obtained with a steel tube.

It is possible to bring another variable into the investigation, and thus increase the exactness of the compensation, by constructing the telescope-tube of two parts of different materials. This may not be desirable for meridian-circles, but probably not objectionable for equatorials. Professor WADSWORTH suggests one combination of steel and nickel steel.

This subject of changes in focal length is of great importance in all meridian-circle, heliometer, photographic, micrometric, and spectrographic work, and designers of instruments will do well to take heed of the results obtained by Professor WADSWORTH. S. D. T.

The leading article in the *Astrophysical Journal* for October is one by Dr. HARTMANN, entitled "A Revision of Rowland's System of Wave-Lengths." By way of introduction, Dr. HARTMANN says: "ROWLAND'S system of wave-lengths has become the basis of all spectroscopic measurements made in recent years, and with the progressive increase in the precision of these measures the necessity has now arisen of testing the reliability of that important basis, and, in case it should not appear as adequate, of correcting it by new series of observa-

tions, in order thus to create a foundation sufficient for all demands."

Dr. HARTMANN then goes on to explain the methods used by ROWLAND in determining the wave-lengths of the various tables published by him, concluding that ROWLAND's "Preliminary Table of Solar Spectrum Wave-Lengths" is the most accurate. Even this table, however, according to HARTMANN's investigation, has a small systematic error running through it, but he thinks it is now possible to determine the necessary corrections to ROWLAND's wave-lengths. Special and delicate apparatus will be required for carrying out this work, and HARTMANN suggests that it would be advisable to have these researches carried out independently at a number of places.

S. D. T.

Sir WILLIAM RAMSAY, F. R. S., addressed the British Astronomical Association in London recently on "Some Speculations Regarding Stars and Atoms." In 1878 the French astronomer JANSSEN, and Sir NORMAN LOCKYER, in England, discovered a line in the Sun's spectrum near that which marks the presence of sodium, and, as it was then supposed to indicate an element peculiar to the Sun and unknown on Earth, it was called helium. Sir WILLIAM, by careful search, detected this supposed unknown element in the mineral clevite. The discovery came most opportunely, for it followed the finding of argon in the atmosphere, and helium belongs to the same class as argon, in being an inert body incapable of forming combinations with others. Since then other similar elements—neon, krypton, xenon—have been identified in the air, and they are of the same inert class. But these elements, especially helium and krypton, seem to afford an alluring link connecting terrestrial physics and chemistry with those of the Sun and stars. One of the speculations on which Sir WILLIAM ventured was, that the action of krypton may explain that hitherto obscure phenomenon, the aurora borealis. There is now reason to believe, as one outcome of the examination of radio-active bodies, that the Sun not only sends out rays of light and heat, but is also continually projecting into space corpuscles of electrified matter which electrify the regions of the upper atmosphere. It has long been thought that the aurora was an

electrical phenomenon. Its radiant arch and brilliant streamers give this impression naturally. The problem was to identify the constituent of the atmosphere which was the subject of the electrifying action. Professor RAMSAY believes that he has discovered that constituent in krypton. In the ocean of air above us a ceaseless circulation is going on between the tropics and the polar regions, the heated air of the equatorial zone flowing northward at a great elevation, while the polar currents return at a lower level to the tropics. There is cause for thinking that krypton, though a heavy gas, ascends to the higher regions, because the element, being monatomic, would be more powerfully affected by tropical heat than elements like hydrogen and oxygen, made up of molecules of two atoms. And in those upper regions of the air we can suppose that it is electrified by solar corpuscles, and, becoming denser in the polar circle, gives out the aurora discharge. More than this, Sir WILLIAM showed that in a laboratory experiment with air in a globe containing krypton an auroral light can be produced. Moreover, the spectrum of the aurora and of krypton appear to be identical. Having described the discovery by BECQUEREL of the principle of radio-activity, and the isolation by Madame CURIE of the most wonderful example of that principle with radium, Sir W. RAMSAY explained the three species of radiations from radium,—the *alpha* rays, which are easily stopped; the *beta* rays, which are more penetrating (these two being material corpuscles charged with electricity); and the *gamma* rays, which will go through several inches of lead, and are undulations of ether resembling those of light or electricity. Besides these was the emanation of a heavy gas leaving a residuum, which he and Mr. SODDY had proved to be helium. Professor J. J. THOMSON had made it probable that the corpuscles given off by atoms were electrons, the *alpha* rays being positively and the *beta* negatively electrified; and they could conceive of an atom as a system in which a large number of small bodies might be revolving round a center.

Dr. JOHNSTONE STONEY had pointed out that there was probably a natural limit to the size of the suns and stars. When a sun exceeded a certain volume a portion of its mass would be thrown off. So it might be with the atom. In uranium and radium they had the heaviest known elements,

and these, passing the natural limit of atomic dimensions, might be throwing off the electrons which in the case of radium produced such marvelous effects.—*Extract from the Scotsman.*

Harnessing the Dog Star.—A French astronomer, M. TOUCHET, who has previously photographed objects by the light of *Venus* and *Jupiter,* has now succeeded in obtaining a photograph by the light of *Sirius,* the most brilliant of all the stars. An ordinary camera was used, but the customary objective was replaced by a cardboard tube, to the end of which a small brooch, the object it was intended to photograph, was affixed. The light of the star was concentrated upon the brooch through a powerful lens, and the exposure lasted an hour and five minutes. The result was an admirable photograph of the star with a clear reproduction of the brooch in its center. When it is remembered, says the *Debats,* that *Sirius* is ninety-two trillion of kilometers from the Earth, and that its light takes nine years and nine months to reach us, the rays which permitted the photograph to be taken must have been traveling through space since 1894 at the tremendous rate of 187,500 miles per second.—*Dalziel, London Daily Graphic, Dec. 5, 1903.*

A Royal Medal of the Royal Society has been awarded to Sir DAVID GILL, K. C. B., F. R. S., for his researches in solar and stellar parallax, and his energetic direction of the Royal Observatory at the Cape of Good Hope.

It is reported that among the subjects now under consideration by the Carnegie Institution in connection with grants are a solar observatory, a southern observatory, a geophysical observatory, and the establishment of international magnetic researches.

Transit-room shutters of a new design by Professor D. P. TODD were erected the last week in November at Amherst College Observatory. They were built by the Coburn Trolley Track Company and the Norton Iron Works, with special reference to ease and rapidity of working.—*Science, Dec. 18, 1903.*

Our amateur astronomers may be interested in the brief description, in the January number of *Popular Astronomy,* of a fourteen-foot dome built by one of our members, Mr. C. F. HARMS, of Brooklyn, N. Y. It is a good solution of the problem to attach to a residence, at a reasonable cost, a dome answering all reasonable demands.

Mr. ANDREW GRIEG sends us the following interesting extract from the *Scotsman:* "In a recent lecture on 'Other Worlds than Our Own,' Sir ROBERT BALL said we were most interested in our next-door neighbors, *Venus* and *Mars.* With regard to *Venus,* the Professor accepts as proved the theory on which Mr. WALLACE relies, that it always turns the same face to the Sun, so that one hemisphere has perpetual night, and the other unending day. He did not think that *Venus* was now the habitation of rational beings. Life there might be, but scarcely that of sentient beings like ourselves. Looking at the scores of millions of years of this world's existence, and the fact that 100,000 years would be a liberal estimate for human history, it seemed scarcely likely that rational life on *Venus* would be simultaneous with that here.

" For various reasons Sir ROBERT was inclined to think that no other planet of the solar system is likely to be inhabited at present by creatures like ourselves. In some the time is past; in others it may be yet to come. In time past the Moon may have been inhabited, but no distinct trace of atmosphere is now found, and its seas seem to have sunk into the cavernous interior, as most probably some day the Earth's seas will do.

" Professor BALL dismisses the canals of *Mars* as optical illusions, and is disposed to believe that we see few if any seas on its surface, but rather certain areas capable of supporting vegetation, and others desert. The pictures of *Jupiter* seemed to suggest that the planet was still too hot to be peopled—not through the Sun's heat, for that was only one twentieth of what we received—but in consequence of *Jupiter's* own high temperature as a cooling globe. What water exists is most likely not on the planet's surface, but is carried as vapor in its vast atmosphere. A succession of lime-light pictures was thrown on the screen to emphasize the transcendent grandeur of the stellar universe, and the countless number of worlds

which it must contain. We see only the suns and bright nebulæ, but the dark unseen worlds were almost certainly many times more numerous. While rejecting the idea of an infinite universe with an infinite number of suns,—because then the firmament would be a blaze of light,—he enforced the thought that the whole of this group of worlds had a greater design than merely to teach man his insignificance, and that it was reasonable to suppose as there were suns vastly greater than ours, so there were many 'other worlds than ours,' some of them inhabited by beings of far greater capacities."

THE MOON: A SUMMARY OF THE EXISTING KNOWLEDGE OF OUR SATELLITE. With a complete Photographic Atlas. By WILLIAM H. PICKERING, of Harvard College Observatory. One hundred illustrations. New York: Doubleday, Page & Company, 1903. Price, special net, $10.00.

Although the title as given above states that this volume is a summary of the existing knowledge of our satellite, the author in the first sentence of his preface says, "It is intended in the present volume to give an account of some of the more recent advances in our knowledge of the Moon, leaving to the text-books a statement of the information that was earlier acquired." In point of fact the volume is chiefly devoted to the results of Professor PICKERING'S personal selenographical studies, particularly those made in Jamaica in 1901, touching upon other matters in the earlier chapters only so far as necessary to a better understanding of those observations.

One chapter, however, headed "Fancies; Apparent Size; Superstitions; Influence on the Weather," is added that has no particular bearing on the subject-matter of the rest of the volume, and is apparently introduced to make the work more "popular."

It is impossible at the present time to review this work critically. Such a task may more properly be undertaken by one who has made a specialty of selenography. It is my purpose merely to give a very brief account of the author's views, which in some respects are unusual and not as yet accepted by astronomers generally as fully substantiated.

The first point to attract attention is the claim made that any station situated near the equator possesses superior atmospheric conditions for astronomical work. Reading the preface, one would gather that nearness to the equator was the necessary and sufficient condition for a "steady" atmosphere, whether the station be located on an island or high up among lofty mountains. From such a location the author claims that a twelve-inch telescope will show planetary details invisible in the largest telescopes of this country and Europe. "What is now needed," he adds, "is a large telescope located near the equator, but just how near it is necessary or desirable to go has not as yet been definitely determined."

Passing on to the text, we find that the opening chapters treat of "The Moon's Origin; Its Relation, Distance, Orbit," etc. Then follow chapters on its Atmosphere and Temperature; the Origin of Lunar Craters, with an account of some miniature craters formed experimentally; Active Lunar Craters; Ice on the Moon; Vegetation and the Lunar Canals; and Recent Investigations. These chapters deal principally with Professor PICKERING'S own observations, and the theories he has framed to interpret them. Then comes the chapter on "Fancies," etc., already mentioned, which in turn is followed by an account of the formation and arrangement of the photographic atlas of eighty plates, which, with a good guide-map, concludes the volume.

We find that Professor PICKERING agrees with astronomers generally in believing that the density of the Moon's atmosphere "does not exceed the one ten-thousandth part of our own." But he thinks that we have positive evidence that a very tenuous atmosphere does exist on the Moon and that it is "a factor in selenography by no means negligible." Since he agrees with other investigators in thinking that our ordinary atmospheric gases—oxygen, nitrogen, and in fact all gases, except perhaps the very heavy ones, like carbonic acid—would probably have escaped from the surface of the Moon long ere this, he finds the source of the present lunar atmosphere in gases "constantly renewed from the Moon's interior." "Let us now see," he proceeds, "what gases are at the present time being given off from the Earth's interior. We find that there are only two that escape in large quantities—carbonic acid and

water-vapor. The former would remain for some time on the Moon's surface on account of its weight, and the latter because on account of the low pressure the rapid evaporation would cause it immediately to freeze."

Here we have at once the origin of the Moon's atmosphere, and of the "snow," or "hoar-frost," of which a great deal is said in the later chapters.

The discussion of the origin of the lunar craters and the account of miniature craters observed in cooling slag-iron, and others artificially formed from cooling paraffin, are very interesting, and will leave little doubt in the minds of most readers that the source of the lunar craters was volcanic activity.

The following chapters are devoted to the discussion of gradual changes that various observers have noted in such craters as *Linné* and *Plato,* and many changes, observed by Professor PICKERING himself, which differ from those noticed earlier, in being periodic, the periods depending on the alternation of the lunar night and day. The explanation of most of these periodic changes the author finds in the exuding of water-vapor from crevices in the Moon's surface, its freezing during the lunar night and its consequent deposit in the neighborhood of the crevices as "hoar-frost," and its more or less complete evaporation during the lunar day. The author presents detailed evidence, illustrated by drawings and photographs, in favor of the reality of these periodic changes and of the adequacy of his theory as to their cause. As was said in the beginning, it is not our purpose to discuss this evidence here; nor can we examine critically the arguments advanced in favor of the theory that certain "variable spots" that Professor PICKERING sees upon the Moon are due to the coming up, flourishing, and dying of low forms of organic life resembling vegetation. These, and the "lunar canals" are matters that must be left to the expert selenographer. We need only say here that they are not yet accepted by astronomers generally without question.

Whatever may be the final judgment as to Professor PICKERING'S observations and theories, there is no question but that the photographic atlas will be found a useful and convenient guide to the amateur observer of the Moon. It is composed of

eighty plates, reproduced without enlargement from as many negatives, which were taken by Professor PICKERING in Jamaica in 1901. His instrument was a twelve-inch lens of 135 feet 4 inches focal length. The Moon's equatorial diameter was divided into eight equal parts and perpendiculars drawn to it, cutting the lunar surface into sixteen areas. Each area was photographed five times, at lunar sunrise, noon, and sunset, and at two intermediate times, designated as morning and evening.

Examination of the atlas indicates that the negatives were generally good, but in many cases they have not been reproduced in a manner altogether satisfactory. Large-scale photographs like those issued by the Lick and Paris observatories are, of course, to be preferred for many purposes, but they are not readily accessible. The present atlas is on a scale sufficiently large for general use, and its completeness and systematic arrangement, together with its full index and its maps, should make it a useful and convenient guide. R. G. A.